

WHAT IS CLAIMED IS:

1. A light scanner comprising:
 - a light source portion for emitting a light beam having a predetermined
 - 5 wavelength;
 - an optical deflector for scanning the light beam from the light source portion;
 - a first imaging optical system placed between the light source portion and the optical deflector for guiding the light beam from the light source portion
 - 10 to a deflection surface of the optical deflector;
 - a second imaging optical system of a single curved mirror placed between the optical deflector and a surface to be scanned for guiding the light beam from the optical deflector to the surface to be scanned;
 - a scanning start signal detector for detecting the light beam scanned by the
 - 15 optical deflector; and
 - a detecting optical system placed between the optical deflector and the scanning start signal detector for guiding the light beam scanned by the optical deflector to the scanning start signal detector,
 - wherein the first imaging optical system, the optical deflector and the
 - 20 second imaging optical system are located at different positions in a sub-scanning direction so that the light beam from the first imaging optical system enters obliquely with respect to a plane containing a normal to the deflection surface of the optical deflector and being parallel to a main scanning direction, and the light beam from the optical deflector enters
 - 25 obliquely with respect to a plane containing a normal to the curved mirror at its vertex and being parallel to the main scanning direction,
 - an angle θ_M formed by an optical axis of the light beam traveling to the curved mirror and the plane containing the normal to the curved mirror at its vertex and being parallel to the main scanning direction satisfies
 - 30 $10 < \theta_M < 35$,
 - the curved mirror also is part of the detecting optical system, and
 - in the cross section taken along a sub-scanning direction, when the angle of a reflected light beam from the deflection surface of the optical deflector with respect to an incident light beam from the first imaging optical system
 - 35 is measured in a positive direction, the angle of a reflected light beam from the curved mirror with respect to an incident light beam from the deflection surface is measured in a negative direction.

2. The light scanner according to claim 1, wherein the light beam emitted from the light source portion has a wavelength of 500 nm or less.

5 3. The light scanner according to claim 1, satisfying

$$1.6 < \theta_M/\theta_P + 0.98L/(L + D) < 2.2$$

10 where θ_P is an angle between an optical axis of the light beam from the first imaging optical system and the normal to the deflection surface of the optical deflector, L is a distance between the deflection surface of the optical deflector and the vertex of the curved mirror, and D is a distance between the vertex of the curved mirror and the surface to be scanned.

15 4. The light scanner according to claim 3, satisfying

$$Eq. 2 \quad 1.86 < \theta_M/\theta_P + 0.98L/(L + D) < 1.94.$$

20 5. The light scanner according to claim 1, satisfying

$$Eq. 3 \quad 0.48 < L/(L + D) < 0.75$$

25 where L is a distance between the deflection surface of the optical deflector and the vertex of the curved mirror and D is a distance between the vertex of the curved mirror and the surface to be scanned.

6. The light scanner according to claim 1, wherein the curved mirror has an arc-shaped cross section in the sub-scanning direction.

30 7. The light scanner according to claim 1, wherein the curved mirror has a shape for correcting bend of a scanning line caused by oblique incidence of the light beam.

35 8. The light scanner according to claim 1, wherein the curved mirror has a shape that is asymmetrical with respect to the plane containing the normal to the curved mirror at its vertex and being parallel to the main scanning direction.

9. The light scanner according to claim 1, wherein the curved mirror is twisted so that the normal at each point, except the vertex, on a generatrix is not contained in the plane containing the normal to the curved mirror at its vertex and being parallel to the main scanning direction, the generatrix being a curved line intersecting with the plane containing the normal to the curved mirror at its vertex and being parallel to the main scanning direction.
10. The light scanner according to claim 9, wherein the angle formed by the normal at each point on the generatrix and the plane containing the normal to the curved mirror at its vertex and being parallel to the main scanning direction becomes larger as a distance between the vertex and each point increases.
11. The light scanner according to claim 9, wherein when a direction in which a reflected light beam from the curved mirror with respect to an incident light beam from the deflection surface of the optical deflector is identified as a positive direction, a direction in which the normal at each point on the generatrix tilts with respect to the plane containing the normal to the curved mirror at its vertex and being parallel to the main scanning direction is identified as a positive direction.
12. The light scanner according to claim 1, wherein the curved mirror is an anamorphic mirror whose radius of curvature at its vertex is different in the main scanning direction and in the sub-scanning direction.
13. The light scanner according to claim 1, wherein the curved mirror has concave mirror surfaces in the main scanning direction and in the sub-scanning direction.
14. The light scanner according to claim 1, wherein the curved mirror has a mirror surface whose refractive power in the sub-scanning direction is different in a center and a periphery of the main scanning direction.
15. The light scanner according to claim 1, wherein the curved mirror is shaped so that a radius of curvature of a cross section in the sub-scanning

direction is not affected by the shape of a cross section in the main scanning direction.

16. The light scanner according to claim 1, wherein the first imaging
5 optical system converges the light beam from the light source portion in the main scanning direction.

17. The light scanner according to claim 1, wherein the light source
10 portion includes a wavelength-variable light source and a wavelength control portion.

18. The light scanner according to claim 1, further comprising a light
combining means,
15 wherein the light source portion has at least two light sources and the light combining means is placed between the light source portion and the optical deflector so as to combine a plurality of light beams emitted from the at least two light sources.

19. The light scanner according to claim 18, further comprising a light
20 separating means placed between the optical deflector and the surface to be scanned so as to separate the light beam combined by the light combining means into a plurality of light beams.

20. The light scanner according to claim 18, wherein light beams
25 emitted from the at least two light sources have different wavelengths.

21. A light scanner comprising:
a light source portion for emitting a light beam having a predetermined
wavelength;
30 an optical deflector for scanning the light beam from the light source portion;
a first imaging optical system placed between the light source portion and the optical deflector for guiding the light beam from the light source portion to a deflection surface of the optical deflector;
35 a second imaging optical system of a single curved mirror placed between the optical deflector and a surface to be scanned for guiding the light beam from the optical deflector to the surface to be scanned;

a scanning start signal detector for detecting the light beam scanned by the optical deflector; and
 a detecting optical system placed between the optical deflector and the scanning start signal detector for guiding the light beam scanned by the optical deflector to the scanning start signal detector,
 wherein the light source portion, the first imaging optical system, the optical deflector, and the second imaging optical system are located at different positions in a sub-scanning direction so that the light beam from the first imaging optical system enters obliquely with respect to a plane containing a normal to the deflection surface of the optical deflector and being parallel to a main scanning direction, and the light beam from the optical deflector enters obliquely with respect to a plane containing a normal to the curved mirror at its vertex and being parallel to the main scanning direction,
 an angle θ_M formed by an optical axis of the light beam traveling to the curved mirror and the plane containing the normal to the curved mirror at its vertex and being parallel to the main scanning direction satisfies $10^\circ < \theta_M < 35^\circ$,
 the light beam traveling from the curved mirror to the surface to be scanned is substantially equal to that traveling from the curved mirror to the scanning start signal detector, and
 in the cross section taken along a sub-scanning direction, when the angle of a reflected light beam from the deflection surface of the optical deflector with respect to an incident light beam from the first imaging optical system is measured in a positive direction, the angle of a reflected light beam from the curved mirror with respect to an incident light beam from the deflection surface is measured in a negative direction.

22. A light scanner comprising:
 a light source portion for emitting a light beam having a predetermined wavelength;
 an optical deflector for scanning the light beam from the light source portion;
 a first imaging optical system placed between the light source portion and the optical deflector for guiding the light beam from the light source portion to a deflection surface of the optical deflector;
 a second imaging optical system of a single curved mirror placed between

the optical deflector and a surface to be scanned for guiding the light beam from the optical deflector to the surface to be scanned;

a scanning start signal detector for detecting the light beam scanned by the optical deflector; and

- 5 a detecting optical system placed between the optical deflector and the scanning start signal detector for guiding the light beam scanned by the optical deflector to the scanning start signal detector,
wherein the first imaging optical system, the optical deflector, and the second imaging optical system are located at different positions in a
10 sub-scanning direction so that the light beam from the first imaging optical system enters obliquely with respect to a plane containing a normal to the deflection surface of the optical deflector and being parallel to a main scanning direction, and the light beam from the optical deflector enters obliquely with respect to a plane containing a normal to the curved mirror
15 at its vertex and being parallel to the main scanning direction, the light beam traveling from the curved mirror to the surface to be scanned is substantially equal to that traveling from the curved mirror to the scanning start signal detector, and
in the cross section taken along a sub-scanning direction, when the angle of
20 a reflected light beam from the deflection surface of the optical deflector with respect to an incident light beam from the first imaging optical system is measured in a positive direction, the angle of a reflected light beam from the curved mirror with respect to an incident light beam from the deflection surface is measured in a negative direction.

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23. A light scanner comprising:

a light source portion for emitting a light beam having a predetermined wavelength;

an optical deflector for scanning the light beam from the light source
30 portion;

a first imaging optical system placed between the light source portion and the optical deflector for guiding the light beam from the light source portion to a deflection surface of the optical deflector;

- 35 a second imaging optical system of a single curved mirror placed between the optical deflector and a surface to be scanned for guiding the light beam from the optical deflector to the surface to be scanned;
a scanning start signal detector for detecting the light beam scanned by the

optical deflector; and
a detecting optical system placed between the optical deflector and the
scanning start signal detector for guiding the light beam scanned by the
optical deflector to the scanning start signal detector,
5 wherein the light source portion, the first imaging optical system, the
optical deflector, and the second imaging optical system are located at
different positions in a sub-scanning direction so that the light beam from
the first imaging optical system enters obliquely with respect to a plane
containing a normal to the deflection surface of the optical deflector and
10 being parallel to a main scanning direction, and the light beam from the
optical deflector enters obliquely with respect to a plane containing a
normal to the curved mirror at its vertex and being parallel to the main
scanning direction,
an angle θ_M formed by an optical axis of the light beam traveling to the
15 curved mirror and the plane containing the normal to the curved mirror at
its vertex and being parallel to the main scanning direction satisfies $10 <$
 $\theta_M < 35$,
the light beam traveling from the curved mirror to the surface to be scanned
is substantially equal to that traveling from the curved mirror to the
20 scanning start signal detector, and
the light source portion is turned on so as to perform automatic power
control operation at any time during a period between completion of a
present scanning of a printing region followed by transmission of a light
beam through a portion of the surface to be scanned that corresponds to an
25 end of a recording paper and detection of a light beam of the next scanning
by the scanning start signal detector.

24. A light scanner comprising:
a light source portion for emitting a light beam having a predetermined
30 wavelength;
an optical deflector for scanning the light beam from the light source
portion;
a first imaging optical system placed between the light source portion and
the optical deflector for guiding the light beam from the light source portion
35 to a deflection surface of the optical deflector;
a second imaging optical system of a single curved mirror placed between
the optical deflector and a surface to be scanned for guiding the light beam

from the optical deflector to the surface to be scanned;
a scanning start signal detector for detecting the light beam scanned by the
optical deflector; and
a detecting optical system placed between the optical deflector and the
5 scanning start signal detector for guiding the light beam scanned by the
optical deflector to the scanning start signal detector,
wherein the first imaging optical system, the optical deflector, and the
second imaging optical system are located at different positions in a
sub-scanning direction so that the light beam from the first imaging optical
10 system enters obliquely with respect to a plane containing a normal to the
deflection surface of the optical deflector and being parallel to a main
scanning direction, and the light beam from the optical deflector enters
obliquely with respect to a plane containing a normal to the curved mirror
at its vertex and being parallel to the main scanning direction,
15 the light beam traveling from the curved mirror to the surface to be scanned
is substantially equal to that traveling from the curved mirror to the
scanning start signal detector, and
the light source portion is turned on so as to perform automatic power
control operation at any time during a period between completion of a
20 present scanning of a printing region followed by transmission of a light
beam through a portion of the surface to be scanned that corresponds to an
end of a recording paper and detection of a light beam of the next scanning
by the scanning start signal detector.

25 25. An image forming apparatus comprising the light scanner according
to claim 1.

26. A color image forming apparatus comprising:
a plurality of image forming units for different colors, each comprising a
30 developing device and a photosensitive member and being held to form a
cylinder;
a conveying means for moving each of the image forming units between an
image forming position and a waiting position by rotating the image forming
units simultaneously around an axis of the cylinder;
35 a transfer means for forming a color toner image on a member to be
transferred by bringing the photosensitive member of the image forming
unit at the image forming position into contact with the member to be

transferred and successively transferring toner images of different colors formed on each of the photosensitive members to the member to be transferred in accordance with switching of the image forming units to be positioned in the image forming position so as to superimpose the toner images of different colors; and

5 a light scanner for exposing the photosensitive member, wherein the light scanner comprises:

a light source portion for emitting a light beam having a predetermined wavelength;

10 an optical deflector for scanning the light beam from the light source portion;

a first imaging optical system placed between the light source portion and the optical deflector for guiding the light beam from the light source portion to a deflection surface of the optical deflector;

15 a second imaging optical system of a single curved mirror placed between the optical deflector and a surface to be scanned for guiding the light beam from the optical deflector to the surface to be scanned;

a scanning start signal detector for detecting the light beam scanned by the optical deflector; and

20 a detecting optical system placed between the optical deflector and the scanning start signal detector for guiding the light beam scanned by the optical deflector to the scanning start signal detector,

wherein the first imaging optical system, the optical deflector and the second imaging optical system are located at different positions in a

25 sub-scanning direction so that the light beam from the first imaging optical system enters obliquely with respect to a plane containing a normal to the deflection surface of the optical deflector and being parallel to a main scanning direction, and the light beam from the optical deflector enters obliquely with respect to a plane containing a normal to the curved mirror

30 at its vertex and being parallel to the main scanning direction, an angle θ_M formed by an optical axis of the light beam traveling to the curved mirror and the plane containing the normal to the curved mirror at its vertex and being parallel to the main scanning direction satisfies $10 < \theta_M < 35$,

35 the curved mirror also is part of the detecting optical system, and in the cross section taken along a sub-scanning direction, when the angle of a reflected light beam from the deflection surface of the optical deflector

with respect to an incident light beam from the first imaging optical system is measured in a positive direction, the angle of a reflected light beam from the curved mirror with respect to an incident light beam from the deflection surface is measured in a negative direction.

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27. A color image forming apparatus comprising:

a plurality of image forming units for different colors, each comprising a developing device and a photosensitive member and being held to form a cylinder;

10 a conveying means for moving each of the image forming units between an image forming position and a waiting position by rotating the image forming units simultaneously around an axis of the cylinder;

a transfer means for forming a color toner image on a member to be transferred by bringing the photosensitive member of the image forming

15 unit at the image forming position into contact with the member to be transferred and successively transferring toner images of different colors formed on each of the photosensitive members to the member to be transferred in accordance with switching of the image forming units to be positioned in the image forming position so as to superimpose the toner

20 images of different colors; and

a light scanner for exposing the photosensitive member, wherein the light scanner comprises:

a light source portion for emitting a light beam having a predetermined wavelength;

25 an optical deflector for scanning light beam from the light source portion;

a first imaging optical system placed between the light source portion and the optical deflector for guiding the light beam from the light source portion to a deflection surface of the optical deflector;

a second imaging optical system of a single curved mirror placed between

30 the optical deflector and a surface to be scanned for guiding the light beam from the optical deflector to the surface to be scanned;

a scanning start signal detector for detecting the light beam scanned by the optical deflector; and

a detecting optical system placed between the optical deflector and the

35 scanning start signal detector for guiding the light beam scanned by the optical deflector to the scanning start signal detector,

wherein the light source portion, first imaging optical system, the optical

deflector and the second imaging optical system are located at different positions in a sub-scanning direction so that the light beam from the first imaging optical system enters obliquely with respect to a plane containing a normal to the deflection surface of the optical deflector and being parallel to a main scanning direction, and the light beam from the optical deflector enters obliquely with respect to a plane containing a normal to the curved mirror at its vertex and being parallel to the main scanning direction, an angle θ_M formed by an optical axis of the light beam traveling to the curved mirror and the plane containing the normal to the curved mirror at its vertex and being parallel to the main scanning direction satisfies $10 < \theta_M < 35$, the light beam traveling from the curved mirror to the surface to be scanned is substantially equal to that traveling from the curved mirror to the scanning start signal detector, and in the cross section taken along a sub-scanning direction, when the angle of a reflected light beam from the deflection surface of the optical deflector with respect to an incident light beam from the first imaging optical system is measured in a positive direction, the angle of a reflected light beam from the curved mirror with respect to an incident light beam from the deflection surface is measured in a negative direction.

28. A color image forming apparatus comprising:
a plurality of image forming units for different colors, each comprising a developing device and a photosensitive member and being held to form a cylinder;
a conveying means for moving each of the image forming units between an image forming position and a waiting position by rotating the image forming units simultaneously around an axis of the cylinder;
a transfer means for forming a color toner image on a member to be transferred by bringing the photosensitive member of the image forming unit at the image forming position into contact with the member to be transferred and successively transferring toner images of different colors formed on each of the photosensitive members to the member to be transferred in accordance with switching of the image forming units to be positioned in the image forming position so as to superimpose the toner images of different colors; and
a light scanner for exposing the photosensitive member, wherein the light

scanner comprises:

a light source portion for emitting a light beam having a predetermined wavelength;

an optical deflector for scanning the light beam from the light source portion;

a first imaging optical system placed between the light source portion and the optical deflector for guiding the light beam from the light source portion to a deflection surface of the optical deflector;

a second imaging optical system of a single curved mirror placed between the optical deflector and a surface to be scanned for guiding the light beam from the optical deflector to the surface to be scanned;

a scanning start signal detector for detecting the light beam scanned by the optical deflector; and

a detecting optical system placed between the optical deflector and the scanning start signal detector for guiding the light beam scanned by the optical deflector to the scanning start signal detector,

wherein the first imaging optical system, the optical deflector, and the second imaging optical system are located at different positions in a sub-scanning direction so that the light beam from the first imaging optical system enters obliquely with respect to a plane containing a normal to the deflection surface of the optical deflector and being parallel to a main scanning direction, and the light beam from the optical deflector enters obliquely with respect to a plane containing a normal to the curved mirror at its vertex and being parallel to the main scanning direction

the light beam traveling from the curved mirror to the surface to be scanned is substantially equal to that traveling from the curved mirror to the scanning start signal detector, and

in the cross section taken along a sub-scanning direction, when the angle of a reflected light beam from the deflection surface of the optical deflector with respect to an incident light beam from the first imaging optical system is measured in a positive direction, the angle of a reflected light beam from the curved mirror with respect to an incident light beam from the deflection surface is measured in a negative direction.

29. A color image forming apparatus comprising:

a plurality of image forming units for different colors, each comprising a developing device and a photosensitive member and being held to form a

cylinder;

a conveying means for moving each of the image forming units between an image forming position and a waiting position by rotating the image forming units simultaneously around an axis of the cylinder;

- 5 a transfer means for forming a color toner image on a member to be transferred by bringing the photosensitive member of the image forming unit at the image forming position into contact with the member to be transferred and successively transferring toner images of different colors formed on each of the photosensitive members to the member to be
- 10 transferred in accordance with switching of the image forming units to be positioned in the image forming position so as to superimpose the toner images of different colors; and
- a light scanner for exposing the photosensitive member, wherein the light scanner comprises:
- 15 a light source portion for emitting a light beam having a predetermined wavelength;
- an optical deflector for scanning light beam from the light source portion;
- a first imaging optical system placed between the light source portion and the optical deflector for guiding the light beam from the light source portion
- 20 to a deflection surface of the optical deflector;
- a second imaging optical system of a single curved mirror placed between the optical deflector and a surface to be scanned for guiding the light beam from the optical deflector to the surface to be scanned;
- a scanning start signal detector for detecting the light beam scanned by the
- 25 optical deflector; and
- a detecting optical system placed between the optical deflector and the scanning start signal detector for guiding the light beam scanned by the optical deflector to the scanning start signal detector,
- wherein the light source portion, the first imaging optical system, the
- 30 optical deflector, and the second imaging optical system are located at different positions in a sub-scanning direction so that the light beam from the first imaging optical system enters obliquely with respect to a plane containing a normal to the deflection surface of the optical deflector and being parallel to a main scanning direction, and the light beam from the
- 35 optical deflector enters obliquely with respect to a plane containing a normal to the curved mirror at its vertex and being parallel to the main scanning direction,

- an angle θ_M formed by an optical axis of the light beam traveling to the curved mirror and the plane containing the normal to the curved mirror at its vertex and being parallel to the main scanning direction satisfies $10 < \theta_M < 35$,
- 5 the light beam traveling from the curved mirror to the surface to be scanned is substantially equal to that traveling from the curved mirror to the scanning start signal detector, and
the light source portion is turned on so as to perform automatic power control operation at any time during a period between completion of a
- 10 present scanning of a printing region followed by transmission of a light beam through a portion of the surface to be scanned that corresponds to an end of a recording paper and detection of a light beam of the next scanning by the scanning start signal detector.
- 15 30. A color image forming apparatus comprising:
a plurality of image forming units for different colors, each comprising a developing device and a photosensitive member and being held to form a cylinder;
a conveying means for moving each of the image forming units between an
- 20 image forming position and a waiting position by rotating the image forming units simultaneously around an axis of the cylinder;
a transfer means for forming a color toner image on a member to be transferred by bringing the photosensitive member of the image forming unit at the image forming position into contact with the member to be
- 25 transferred and successively transferring toner images of different colors formed on each of the photosensitive members to the member to be transferred in accordance with switching of the image forming units to be positioned in the image forming position so as to superimpose the toner images of different colors; and
- 30 a light scanner for exposing the photosensitive member, wherein the light scanner comprises:
a light source portion for emitting a light beam having a predetermined wavelength;
an optical deflector for scanning the light beam from the light source
- 35 portion;
a first imaging optical system placed between the light source portion and the optical deflector for guiding the light beam from the light source portion

to a deflection surface of the optical deflector;
a second imaging optical system of a single curved mirror placed between
the optical deflector and a surface to be scanned for guiding the light beam
from the optical deflector to the surface to be scanned;
5 a scanning start signal detector for detecting the light beam scanned by the
optical deflector; and
a detecting optical system placed between the optical deflector and the
scanning start signal detector for guiding the light beam scanned by the
optical deflector to the scanning start signal detector,
10 wherein the first imaging optical system, the optical deflector, and the
second imaging optical system are located at different positions in a
sub-scanning direction so that the light beam from the first imaging optical
system enters obliquely with respect to a plane containing a normal to the
deflection surface of the optical deflector and being parallel to a main
15 scanning direction, and the light beam from the optical deflector enters
obliquely with respect to a plane containing a normal to the curved mirror
at its vertex and being parallel to the main scanning direction,
the light beam traveling from the curved mirror to the surface to be scanned
is substantially equal to that traveling from the curved mirror to the
20 scanning start signal detector, and
the light source portion is turned on so as to perform automatic power
control operation at any time during a period between completion of a
present scanning of a printing region followed by transmission of a light
beam through a portion of the surface to be scanned that corresponds to an
25 end of a recording paper and detection of a light beam of the next scanning
by the scanning start signal detector.

31. The color image forming apparatus according to any one of claims
26, 27, 28, 29, and 30, wherein the curved mirror constituting the second
30 imaging optical system of the light scanner is located close to the axis of the
cylinder.

32. The color image forming apparatus according to any one of claims
26, 27, and 29, wherein the angle θ_M satisfies $12.5 < \theta_M < 17.5$.
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